

# UPPER RIO GRANDE WATER OPERATIONS MODEL

## Accounting Model Validation

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## INTRODUCTION

This section describes the procedures used to validate the accounting processes for six reservoirs used in the Upper Rio Grande Water Operations Model (URGWOM): Heron, El Vado, Abiquiu, Cochiti, Jemez Canyon, and Elephant Butte Reservoirs. The validation process involves describing the difference between the computation of data parameters (daily storage) using the URGWOM model, which uses RiverWare® as its platform, and the values obtained using the Bureau of Reclamation’s (USBR) FORTRAN program.

## TESTING PROCEDURES

The procedures used in this validation process involve comparing daily reservoir storage values computed using the old USBR FORTRAN daily accounting programs and daily reservoir storage values computed using URGWOM model runs, with the exception of Caballo Reservoir. Because Caballo Reservoir was not included in USBR FORTRAN accounting programs, the validation process is not yet complete. Sediment storage values are based on old (pre-2000) sediment-inflow equations.

The test years used in the validation process are 1995, 1996, and 2000. The daily storage parameters determined in the validation process are summarized for each reservoir in **table 1**.

**Table 1. Identification of parameters used in reservoir accounting validation**

Reservoir	Total storage	Rio Grande storage	San Juan-Chama Project storage	Sediment storage
Heron	X	X	X	--
El Vado	X	X	X	--
Abiquiu	X	X	X	X
Cochiti	X	X	X	X
Jemez Canyon	X	X	X	X
Elephant Butte	X	X	X	--

The validation process involves the following reservoir accounting equations in both the URGWOM model and the FORTRAN daily programs. Total water storage is determined using

elevation-capacity tables. This total storage is divided into Rio Grande and San Juan-Chama Project storage. The general equation for calculation of San Juan-Chama storage is:

$$S_{sjc_t} = S_{sjc_{t-1}} + I_{sjc} - O_{sjc} - NL_{sjc}$$

where:

- $S_{sjc_t}$  = San Juan-Chama storage today, in acre-feet;
- $S_{sjc_{t-1}}$  = San Juan-Chama storage yesterday, in acre-feet;
- $I_{sjc_t}$  = San Juan-Chama inflow, in acre-feet;
- $O_{sjc_t}$  = San Juan-Chama outflow, in acre-feet; and
- $NL_{sjc}$  = San Juan-Chama daily net loss, in acre-feet.

Once the quantity of sediment deposited in the reservoir has been determined using the equations described in the Physical Accounting Model documentation, Rio Grande content is calculated as follows:

$$S_{rg_t} = S_{T_t} - S_{sjc_t} - Sed_v$$

where:

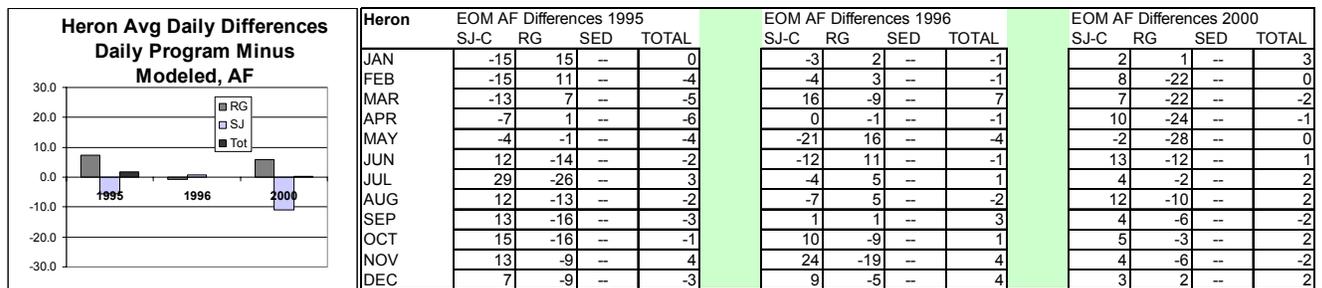
- $S_{rg_t}$  = Rio Grande storage, in acre-feet;
- $S_{T_t}$  = total physical storage, in acre-feet; and
- $Sed_v$  = volume of deposited sediment, in acre-feet.

The process described here is not a true validation in that the daily accounting of such items as San Juan-Chama Project content and reservoir sediment content are not physically measured on a daily basis. The process simply validates that the URGWOM Accounting Model replicates the results of the FORTRAN programs (daily programs).

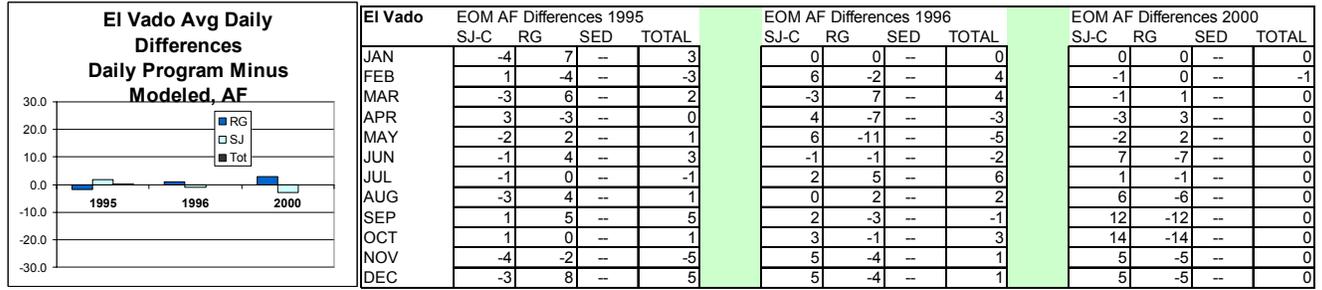
## RESULTS

The results of the validation are summarized in the following graphs and tables.

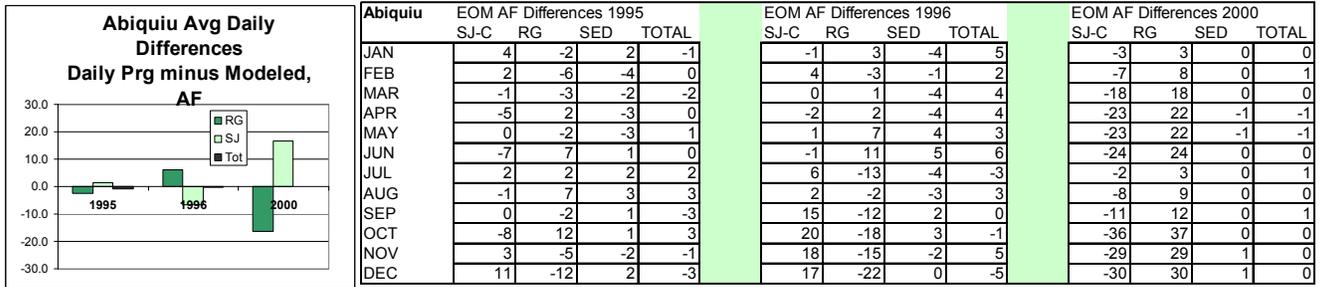
Heron Reservoir: Total storages ranged from 270,000 acre-feet (end of 2000) to 400,000 acre-feet (March 1995).



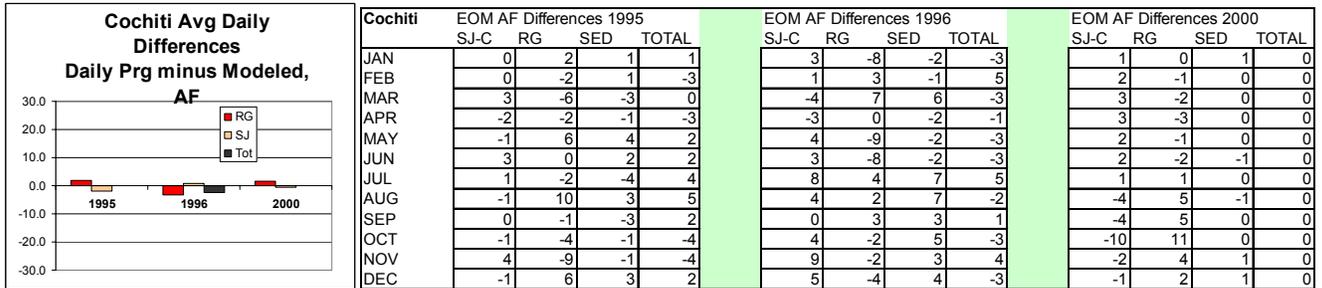
El Vado Reservoir: Total storages ranged from 180,000 acre-feet (April 2000) to 20,000 acre-feet (October 2000).



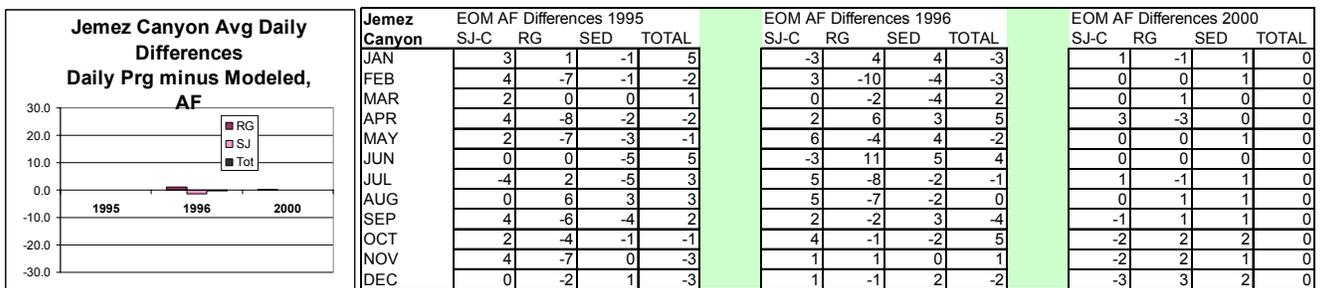
Abiquiu Reservoir: Total storages ranged from 300,000 acre-feet (June 1995) to 70,000 acre-feet (September 2000).



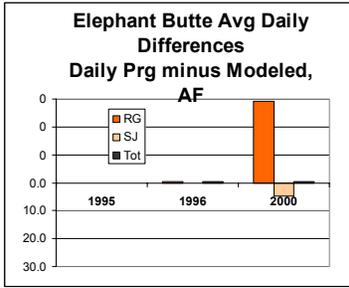
Cochiti Reservoir: Total storages ranged from 100,000 acre-feet (June 1995) to 50,000 acre-feet (September 2000).



Jemez Reservoir: Total storages ranged from 30,000 acre-feet (June 1995) to 4,500 acre-feet (December 2000).



Elephant Butte Reservoir: Total storages ranged from 2,040,000 acre-feet (December 1995) to 1,190,000 acre-feet (September 2000).



Elephant Butte	EOM AF Differences 1995				EOM AF Differences 1996				EOM AF Differences 2000			
	SJ-C	RG	SED	TOTAL	SJ-C	RG	SED	TOTAL	SJ-C	RG	SED	TOTAL
JAN	0	7	--	7	0	-1	--	-1	2	-3	--	-1
FEB	0	8	--	8	0	0	--	0	3	-6	--	-4
MAR	0	-8	--	-8	0	1	--	1	2	3	--	4
APR	0	2	--	2	0	-2	--	-2	-1	2	--	2
MAY	0	2	--	2	0	-1	--	-1	-4	-2	--	-7
JUN	0	0	--	0	0	-1	--	-1	-4	0	--	-4
JUL	0	-4	--	-4	0	3	--	3	-7	12	--	5
AUG	0	-9	--	-9	0	-5	--	-5	-7	9	--	2
SEP	0	5	--	5	0	-5	--	-5	-10	17	--	6
OCT	0	7	--	7	0	0	--	0	-14	11	--	-3
NOV	0	1	--	1	0	-10	--	-10	-12	7	--	-5
DEC	0	7	--	7	0	-2	--	-2	-10	4	--	-6

## CONCLUSIONS

The Physical Accounting Model validation shows that the URGWOM model was able to reliably reproduce accounting results for 1995, 1996, and 2000 within approximately 30 acre-feet per year, on average, for all reservoirs. Most of the differences can be explained by the effects of rounding and by the difference in the way the model and the daily programs use reservoir area-capacity tables. The FORTRAN daily program uses equations and RiverWare uses look-up tables set to the nearest 0.01 foot in elevation.